BTL-4000 LASER

USER'S GUIDE

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1 USER'S GUIDE

1.1 INTRODUCTION

This User's Guide is intended to make you familiar with the BTL-4000 Laser device designed for performing non-invasive, low level laser therapy. At the same time, it will give you general instructions on how to perform low level laser therapy in clinical practice.

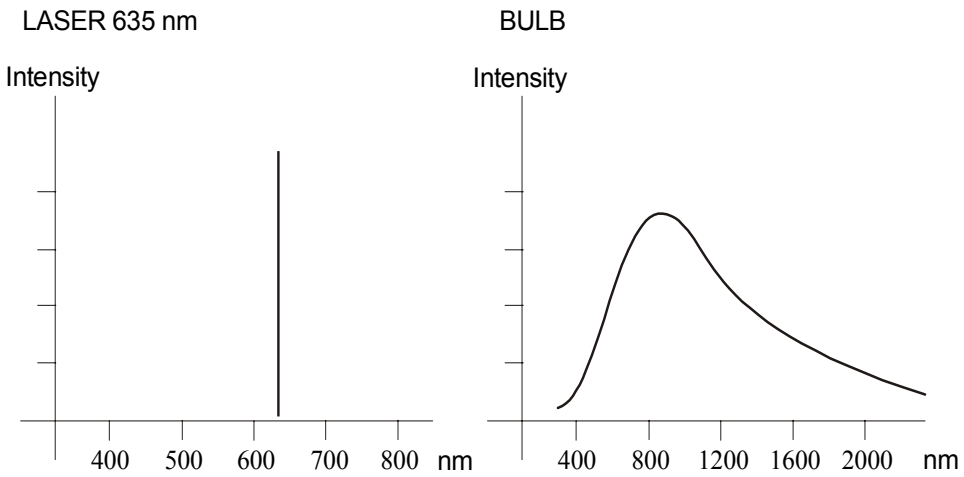
Please note that, according to applicable legislation, the staff operating therapy lasers must be trained by competent institutions.

1.2 LIGHT-THE PRINCIPLE OF LASER LIGHT AND ITS SPECIFICS

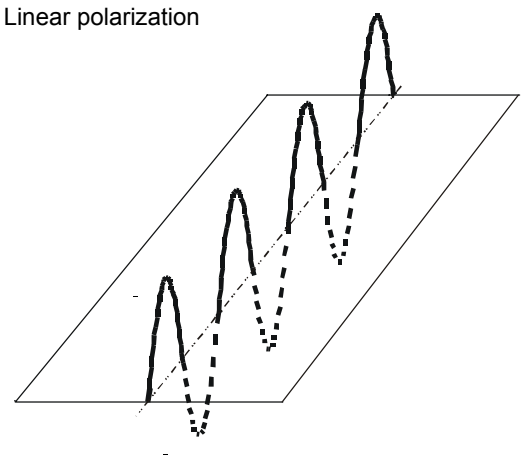
The nature and qualities of light can be interpreted in more ways, according to classic, relativistic or quantum physics. However, the basic nature of light itself as either a particle/corpuscular or an electromagnetic/wave mechanism remains unreachable for our senses and it is incomparable to any other level of reality. Therefore, we can only accept conclusions and deductions of numerous experiments.

Laser radiation has specific qualities:

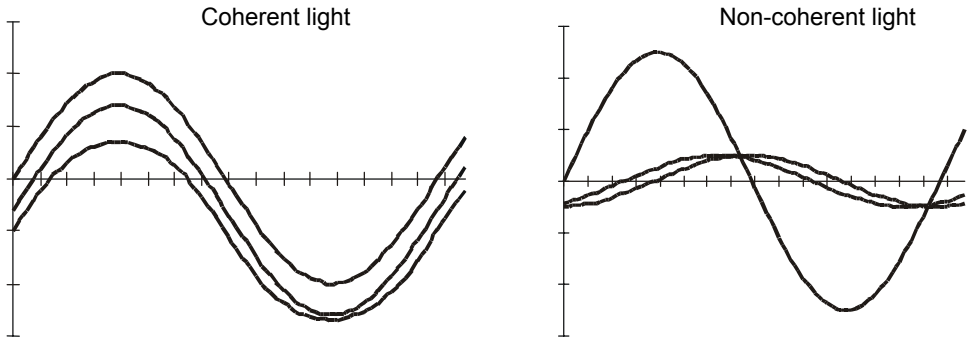
- totally monochromatic: maintaining only one wavelength



- totally polarized – waves are absolutely spatially oriented on a defined area



- totally coherent – it is absolutely oriented in time - maxima and minima of all waves are identical in time and the waveforms are the same



A laser beam of a high output represents the "death ray" of sci-fi authors of old; it can destroy material or matter. However, a laser beam of low output (not exceeding 500 mW) shows slightly different effects on living organisms and tissues, especially significant stimulative effect – see the part concerning clinical effects of low-power laser beam.

The word LASER stands for **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation.

The first theoretical postulates on a laser beam were laid down by Albert Einstein in the early twentieth century, describing the theoretical possibilities of a stimulated emission of light in 1916-1917. However, the first laser unit was not constructed until 1960, following other important discoveries in the area of the so called quantum radiotechnique (N.G. Basov and A.M. Prochorov of the former USSR and C.H. Townes of the USA received a Nobel Prize for these discoveries in 1964).

The medical application of laser light followed soon after. At first, only high intensity laser beams were utilized. Lasers of this type provide a source of energy that can destroy (cut, shear) as well as evaporate and, using its thermic effect, cauterize tissue.

E. Mester, a Hungarian scientist, was the first to introduce the stimulative effect of a low intensity laser. He conducted his experiments - which are still of a great importance - in the late sixties.

1.3 TYPES OF LASERS

Lasers can be divided according to several criteria:

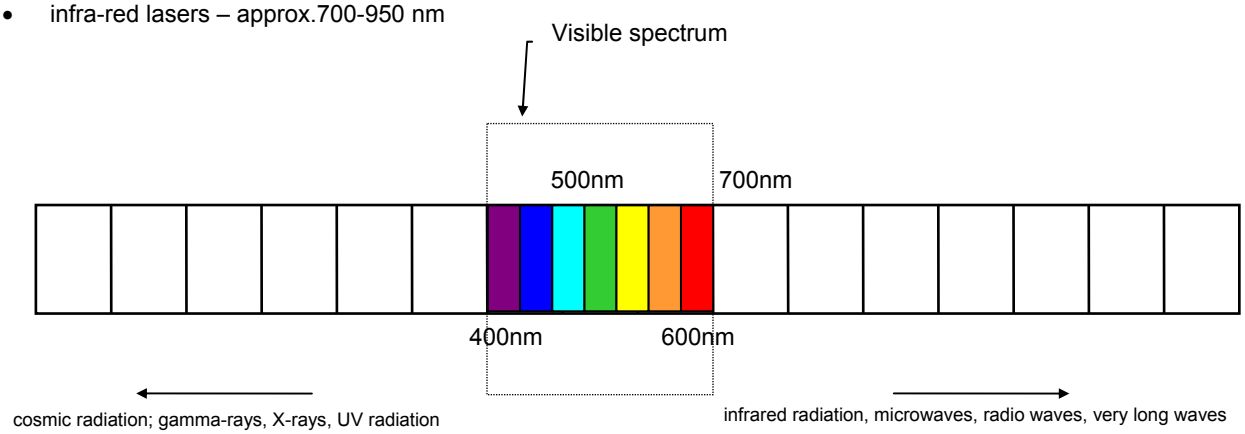
1.3.1 Source

- solid lasers (ruby laser)
- liquid lasers
- gas lasers - helium-neon, argon
- semi-conductor lasers (GaAs, GaAlAs) – now the most important of the non-invasive therapy lasers

The advantages of semi-conductor lasers include a significant miniaturization of the source, robustness and immunity to damage and the theoretic possibility to construct a laser unit of any wavelength, according to the user's requirements. Nevertheless, some lasers still remain at experimental level (see below).

1.3.2 Wavelength (primarily semi-conductor lasers)

- blue lasers – approx. 400-500 nm
- green lasers – approx.500-550
- red lasers – approx.600-700nm
- infra-red lasers – approx.700-950 nm

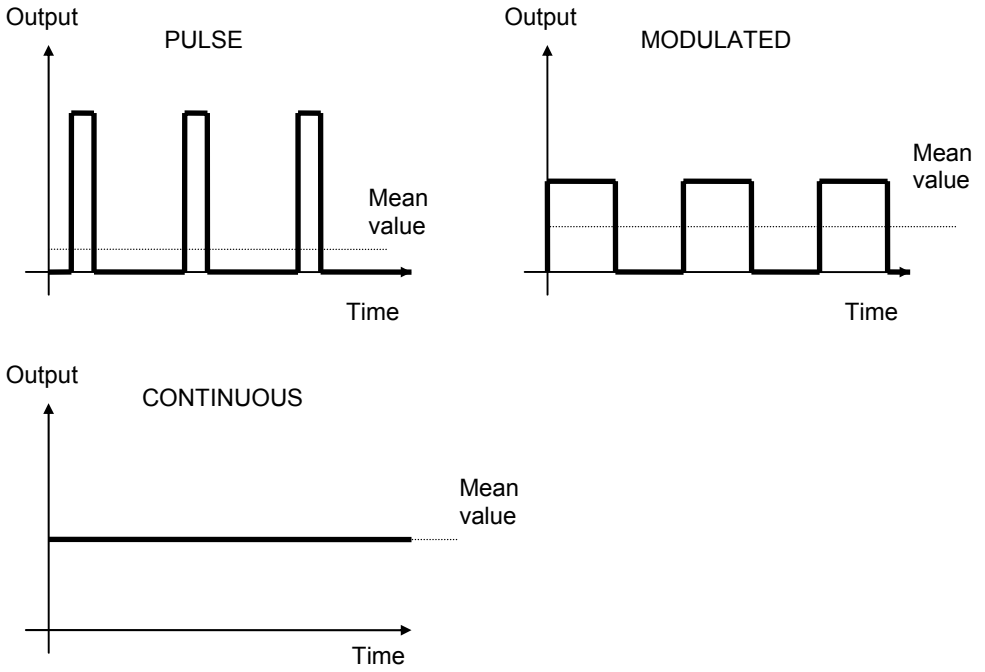


Laser beam penetration through the tissue is largely dependent on the wavelength. In general, green and blue lasers are still being developed and their clinical use is extremely limited. Most commonly used are the beams in the wavelength of red light. After 2-3 mm penetration through living tissue, their intensity is reduced to half. This predetermines red laser beams to be used especially in therapy of mucous membrane and skin diseases. Since the output is absorbed by a very small column of the tissue, devices of an output of 50 mW or lower are usually fully sufficient.

The intensity of infra-red lasers is reduced to half after penetration of 2-3 cm through the tissue. These lasers are used especially in treating of deeper-located structures (joints, muscles, insertions...). Since the output is absorbed by the column of the tissue, and since we want the intensity on the target area deep in the tissue to be sufficient, we recommend using devices of a minimum output at least 50 mW.
See the part concerning the emitted power density below.

1.3.3 Beam Operation Mode

- pulse lasers – very short pulses – hundreds of ns, peak output in watts or tens of watts
- continuous lasers
- lasers with modulated operation – the pulse length depends on the frequency and on the duty factor; the peak output reaches up to several hundreds of mW.



Manufacturers usually offer various alternatives, including the possibility of combination of various modes modulated according to various parameters.
See below the parts concerning clinical effects and use.

1.3.4 Type of Beam

- convergent (point) beam
- divergent (widening) beam – allows irradiation of a larger area without the need of sweeping the probe over the treated tissue
- laser scanners – devices for irradiation of large areas

1.3.5 Laser Class (defined by the output)

- Class 2: up to an output of 1 mW
- Class 3A (3R, 3M): up to an output of 5 mW and output density of 25 W/m^2
- Class 3B: up to 500 mW

Note
The stated values are only rough, exact classification of the hygienic class is more complicated and shall be performed according to applicable standards.

1.3.6 Use

- **simple pen lasers** ("laser-pen") – usually feature only a very limited range of frequency modes. The advantage of this type is its perfect portability
- **"pocket" lasers** – usually designed to fit in a physician's coat pocket; in most cases the probe is connected with the device's body by a conductor – these devices largely prevail on the market, at present the manufacturers can equip these devices by probes of an output up to hundreds of mW
- **desk-top lasers** – usually supplied from the mains, the probe is connected with the device by a cable. The advantages of this type usually include a wide range of frequency modes and the possibility to set many different parameters. New generation devices (including BTL-4000 Laser) have also the possibility of replacement of probes of various wavelengths and outputs. These devices are designed especially for rehabilitation. One of their advantages is the possibility of building of "sets" of the devices which can provide as wide range of treatments as possible on a small area.

1.4 BASIC PHYSICAL QUANTITIES

- **Wavelentgh** - one of the basic parameters of a monochromatic laser beam (i.e. of only one wavelength). Its unit is nanometer [nm]
- **Output** – its unit is mW. The given output is either peak, i.e. pulse amplitude, or mean (average). In case of the BTL 4000 Laser the screen displays the peak output value measured on the output aperture of the probe. Use of an optical attachment or light conductor causes approximately a 10% loss of output which shall be deducted from the displayed value. For each attachment supplied by the manufacturer of BTL devices, the decrease of output is stated in the attachment's technical documentation.
  It is always necessary to know the output level at the active end of the probe (output aperture) – especially when the beam is transmitted by a light conductor, the resulting output can markedly differ from the output of the source! Every passage between media (source-air, source-lightguide, lightguide-air) lowers the output.
  The mean output also depends on the chosen mode, i.e. continuous or pulse (The computing unit of the BTL-4000 Laser takes into account the mode in which the device is working when calculating the treatment time).
- **Modulation frequency –** its unit is Hertz [Hz] (= number of oscillations per second), sometimes there is in addition the percentage value of the active state time ("Duty factor") and the pulse width. The most commonly used are numerical frequencies (5 Hz stimulation, 10 Hz analgesic effect), very common are also frequencies according to Dr. Nogier (previously used mainly in acupuncture), frequencies according to Dr. Bahr (nowadays used mainly in acupuncture) or according to Dr. Voll
- **Power density** - its unit is J/cm^2 – power emitted per unit of area. This quantity is improperly called **dose** – however, this term has become so common in the laser theory that also in this document the terms "emitted power dose" or "dose" are used, but they always mean "emitted power density".

Below you can see a formula for calculation of an emitted power dose (Note: this is the dose emitted to the skin surface, not to more deeply located structures)

$$\text{emitted power dose [J/cm}^2\text{]} = \frac{\text{mean radiation output (W) x application time (s)}}{\text{irradiated area (cm}^2\text{)}}$$

Knowledge of basic physical quantities (which is also acquired in obligatory training) significantly facilitates grasp of the laser therapy.

1.5 BIOLOGICAL EFFECTS OF A LOW-POWER LASER (NON-INVASIVE LASER)

Specific physical qualities of a laser beam result in specific clinical effects. The most considerable clinical effects are:

- analgesic effect **(A)**
- antiphlogistic effect **(F)**
- antiedematous effect **(E)**
- biostimulation effect **(B)**
- vasodilatation effect **(V)**

All these effects are based on positively established and verified mechanisms:

- acceleration of microcirculation
- increase of intracellular activity of many enzymes, particularly in Krebs cycle
- increased oxygen circulation, improved glucose utilization
- DNA synthesis stimulation (via phytohemaglutinin stimulation)
- increased fibroblast activity (for keloids these activated fibroblasts are able to perform resorption of fibrin)
- phagocytosis activation
- activation of the Na/K pump on the membrane
- activation of metabolic processes in the cellula: partly through the Na/K pump and Ca transport affection, partly through direct activation of the mitochondrial system
- changes of local level of important mediators -- inflammatory (histamin substances, prostaglandins) or e.g., endorphins

When performing an in vitro experiment, no difference can be seen between laser beams applied in continuous and pulse modes. However, when performing an in vivo experiment, we observe marked differences between a

continuous beam and a beam adjusted to a certain defined mode. In physical therapy, this phenomenon can be observed when performing electrotherapy or applying ultrasound. It seems that, for a complex organism with its numerous information systems and feedbacks, a physical quantity modulated to a certain frequency features one additional quality -- specific information transmitted by this frequency.

The effect of laser beam in acupuncture is totally specific. A laser beam affects tissue in a way fully comparable with the effect of an inserted needle -- but without any pain or complications related to the needle insertion. The skin above the acupuncture point is a light conductor for the laser beam. We find it interesting that in laser acupuncture, in contrast with other forms of laser therapy, the wavelength of a laser beam is not of a big importance (however, red lasers are slightly more effective) and the output of the device is of no importance at all (we can even use a laser-pen). We conclude that in this method of application it is not the effect of a physical quantity itself, but the above-mentioned transmission of information, that plays the key role.

Many treatments utilize several effects of laser light at a time (e.g. treatment of the varicose ulcer combine analgesic, stimulative, as well as bactericidal effects).

1.6 ACUPUNCTURE

As stated above, laser beam has a specific effect on acupuncture points, adequate to use of an acupuncture needle. The laser acupuncture has several advantages: it is non-invasive, painless (many patients report non-pleasant sensations when acupuncture needle is being inserted), and saves time (even for sedative techniques the treatment lasts no more than several tens of seconds).
Modulation by Nogier frequencies or EAV frequencies is very useful and it is commonly used in acupuncture. Application of these frequencies for the most frequent diagnoses is stated below. For details see specialized literature.

1.6.1 Frequencies for Laser Acupuncture According to Dr.Nogier

Frequency [Hz]	Use and Area of Application
U 1.14	Universal – whole body
A 2.28	Chaotic changes – tissues and transitional epithelium, body openings (mouth, nose, eyes...)
B 4.56	Nutritive effect, chest and abdominal cavity
C 9.12	Mesenchyma, limbs, gluteal area, muscles and ligaments, kidneys, genitals
D 18.3	Metabolism, joints of cerebral symmetric organs
E 36.5	Nerve tissue, peripheral parts of spine, back and top parts of head and neck
F 73.0	Psychosomatic disorders, subcortical areas, lower parts of face
G 146	Emotional diseases, cerebral cortex, nervous system, frontal and temporal parts of head, lateral parts of nose

1.6.2 Frequencies for Laser Acupuncture According to Dr.Voll (EAV)

Frequency [Hz]	Use
1.20	Tachycardia
1.70	Abscess, furunculosis
1.75	Psychostimulating and sympathicotonic effect
2.20	Fatigue, lipothymia, exhaustion, restlessness, pains of legs
2.45	Haematoma, edema, excessive menstrual bleeding associated with myoma, bleeding from varices, insomnia, vegetative disorders, sinusitis
2.50	Distortions, vegetative distrophy
2.65	Gallbladder dystonia, periostitis
2.90	Rhinitis
3.30	Arteriosclerosis, arteriosclerotic hypertension
3.50	Lithiasis, renal colic, tremor, melancholy, knee asthenia
3.60	Insomnia, excitability
3.80	All spasms, tongue burn
3.90	Neuralgia, anxiety, sleeping disorders
4.00	Pancreatic disorders, hormonal disorders, menorrhagia, headache, vertigo
4.90	Dysmenorrhea, stiff neck
5.55	Angiospasms with paresthesis
5.80	Fear, vertigo, headache
5.90	Spastic paralysis
6.00	Parasympathicotonic effect, hypertension, spasmodic stiff neck
6.30	Irritability, headache
6.80	Muscle cramps
7.50	Neuralgia n. trigemini
7.70	Spastic paralysis
8.25	Paralytic paralysis
9.20	Eczema connected with kidney secretory function disorder, hypertension with increased diastole, renal insufficiency
9.35	Paralytic paralysis
9.40	Cystitis, prostate diseases, diseases of large intestine, bronchitis, eczema accompanying lung and vascular diseases, gout, joint aches, stomach problems including ulcers, paresis, varix, haemorrhoids
9.45	Angina, angina pectoris, disorders of hypophysis and gonads
9.50	Spastic hypertension, climacteric hypertension, migraine, laryngitis
9.60	Arthritis, rheumatic diseases, vertebrogenous diseases
9.70	Ischialgia, rheumatism
10.00	Phlebitis, varicose ulcer

2 SETUP OF LASER GENERATOR

2.1 ACCESS PASSWORD

According to applicable standards, each laser device must be protected against unauthorized handling. In case of the BTL-4000 series, it is guaranteed by the access password. If the device contains a laser generator, the access password is always required after the unit is switched on. **The password is preset to 0000 by the manufacturer**. After entering the correct password and confirmation by the **enter** button it is possible to work with the device. If an incorrect password is entered, the device makes a warning and awaits a new entry.
The password can be changed at any time, but it cannot be disabled. For the process of password change, see Chapter **3.2.1 Password Setting** in the **BTL-4000 Series USER'S MANUAL**

Note
If you happen to forget your password, you can anytime use the universal one: 00000000.

2.2 SETUP AND CONTROL OF LASER THERAPY

On the therapy parameters screen it is possible to select individual laser therapies or laser sequences.

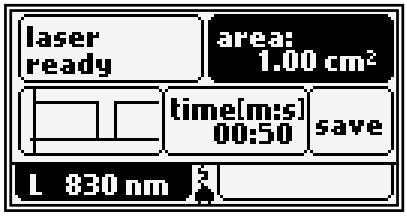
All pre-set therapy values are interconnected by the following mathematical relation:

Dose = Output * (DF/100) * Time / Area [J/cm^2; W, %, s, cm^2]

All pre-set values except frequency influence each other, and the device always tries to calculate the therapy parameters in the way that the last pre-set parameter is at the value set by the user. Other parameters can be changed, if necessary (except dose which is a key therapy parameter). Maximum values of parameters strongly depend on the maximum power of the connected laser probe; therefore, some values can be set for the probe with the output of 300mW but they are not allowed for the 30mW probe. When calculating therapy parameters the device tries, if necessary, to adjust the output of the probe so that the therapy time is 1 minute.

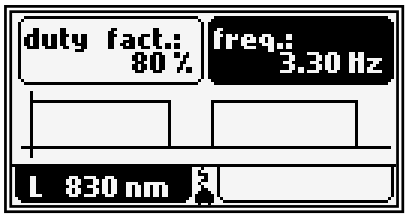
2.2.1 Laser

2.2.1.1 Dose



This value represents the power density to the area [J/cm^2]
It is a key therapy parameter – therefore its value is a fixed part of the program (diagnosis) and the device does not change it at internal calculations (the user can change it freely). Dose can be changed within the range stated in the technical parameters of the device. It is the maximum range, and in practice, with some types of probes it is not possible to reach the upper limit because they do not have enough power for it and the necessary time of therapy would exceed the limit of 99:59.
After pressing the dose button it is possible to set dose by steps by the **select** knob. It is also possible to set the value directly by the numerical keyboard (see chapter **2.4.2 Numerical keyboard** of the **BTL-4000 Series USER'S MANUAL**). Under the displayed current value of dose there are "quick jump" buttons – after pressing one of them the dose value changes to the value written on the button and further setting goes on from this value.

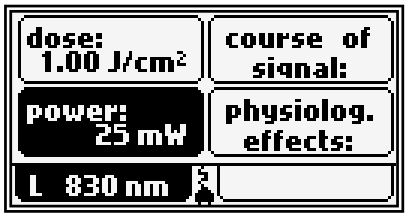
2.2.1.2 Frequency



This parameter states the number of cycles in the time interval of 1 sec, its unit is Hertz [Hz].
The equipment works either in continuous (i.e. uninterrupted) or in pulse mode. If the zero value of the laser beam output frequency is set, the equipment works in the so-called continuous mode (it can be also recognized visually – the laser beam shines constantly and does not blink). If a non-zero positive value of frequency is set, the equipment works in the pulse mode

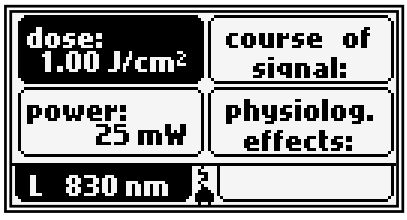
(the laser beam is blinking). Note: the human eye can recognize blinking of the beam up to the frequency of approx. 25 Hz, higher frequencies are subjectively perceived by the human eye as continuous.
Frequency is a second key parameter of therapy – it is also a fixed component of the program (diagnosis) and the device does not change it at internal calculations (the user can change it freely). Frequency can be set within the range stated in the technical parameters of the device. The process of frequency setup is similar to that of other therapy parameters.
After pressing the frequency button it is possible to set frequency by steps by the **select** knob. It is also possible to set the value directly by the numerical keyboard (see Chapter **2.4.2 Numerical keyboard** of the **BTL-4000 Series USER'S MANUAL**). Under the displayed current value of frequency there are "quick jump" buttons – after pressing one of them the frequency value changes to the value written on the button and further setting goes on from this value. Frequency is set by certain preset steps.
Setting frequency to 0 means continuous operation.
Acupuncture therapy requires very precise setting of frequency to the values which cannot be set by steps. In such case it is necessary to enter the exact value of frequency by the numeric keyboard, or to choose the respective program or diagnosis (Nogier, EAV) in which the frequency is set to the required value.

2.2.1.3 Output power



This therapy parameter is the most dependent on the laser probe being used. Each laser probe has a limiting value of minimum and maximum laser beam output which it can generate. The device reads these data from the probe and does not allow to set a value outside this range. When setting other parameters (area, dose) the device sets output in the way that the therapy time is, if possible, 1 minute. If it is necessary to set a certain output value, it is possible to change the output, and the device will automatically calculate other therapy parameters.
After pressing the output button it is possible to set output by steps by the **select** knob. It is also possible to set the value directly by the numerical keyboard (see chapter **2.4.2 Numerical keyboard** of the **BTL-4000 Series USER'S MANUAL**). Under the displayed current value of output there are "quick jump" buttons – after pressing one of them the output value changes to the value written on the button and further setting goes on from this value. Naturally, output can be set only within the range allowed by the connected laser probe.

2.2.1.4 Area

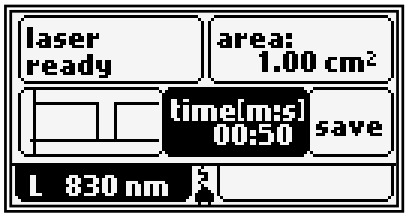


This therapy parameter is often changed by the user because each treated part has a different size. This parameter is also available in the ergonomic mode. When using a divergent probe the screen displays the distance between the probe and the surface so that the irradiated area equals to the pre-set one. The maximum displayed distance is 25 cm, and when irradiating from larger distance the diverged laser beam is too dispersed and therapeutic effects are lower. If the injured area is larger, it is necessary to treat it similarly as with convergent probes and continuously "sweep" over the affected area. With convergent probes, it is necessary to continuously sweep the beam over the whole injured area. When calculating therapy parameters the device assumes that the whole area is irradiated evenly, which is achieved by the above-mentioned continuous sweeping.
The maximum accessible area also depends on the connected laser probe – for low-power probes the maximum area that can be set can be reduced by the device if the maximum therapy time 99:59 could be exceeded.
After pressing the area button it is possible to set the area by steps by the **select** knob. It is also possible to set the value directly by the numerical keyboard (see chapter **2.4.2 Numerical keyboard** of the **BTL-4000 Series USER'S MANUAL**). Under the displayed current value of area there are "quick jump" buttons – after pressing one of them the area value changes to the value written on the button and further setting goes on from this value.
Area can be also changed directly by turning the **intensity** knob.

2.2.1.5 Distance between the Probe and Irradiated Surface

When using convergent probes the distance is not measured because the beam is virtually parallel. This parameter therefore applies only to probes with divergent beam. The distance is a recommended value which is calculated from the relation between the probe's distance from the irradiated surface, divergence of the beam, and the size of the irradiated area. Its unit is centimetre [cm]. Further it is necessary to take into account the required depth of penetration which has to be subtracted from the distance between the probe and body surface.
When using an attachment with lightguide or probes with convergent beam, sweep evenly over the whole pre-set area. During therapy let the beam, if possible, fall vertically on the surface of the tissue, to prevent undesirable reflection and possible reduction of energy absorbed by the tissue. It is advisable to degrease the skin before therapy.

2.2.1.6 Time of Therapy



According to pre-set parameters the device automatically calculates other parameters so that the time of therapy is, if possible, 1 minute. Modification of the calculated time, if necessary, is possible, but it is important to take into account that it will also influence the used probe so that the required dose of therapy is achieved. Maximum time of therapy is 99 minutes and 59 seconds.
In the pulse mode it is possible to modify the time of therapy also by changing the duty factor (DF) value – to shorten the therapy increase the DF.
After pressing the time button it is possible to set time by minutes or seconds. It is also possible to set the value directly by the numerical keyboard (see chapter **2.4.2 Numerical keyboard** of the **BTL-4000 Series USER'S MANUAL**), separately for minutes and for seconds.
Time can be also changed directly by turning the **time** knob.

2.2.1.7 Course of Signal – Duty Factor (DF)

This button serves for displaying of the modulation signal. After pressing this button there appears a screen with the displayed waveform of the output signal. If a non-zero frequency is set, it is possible to change the ratio between the period in which the laser beam does and does not shine, the so-called "Duty Factor". Duty factor can be changed by the **select** knob or by the numerical keyboard.

Adiditional information:

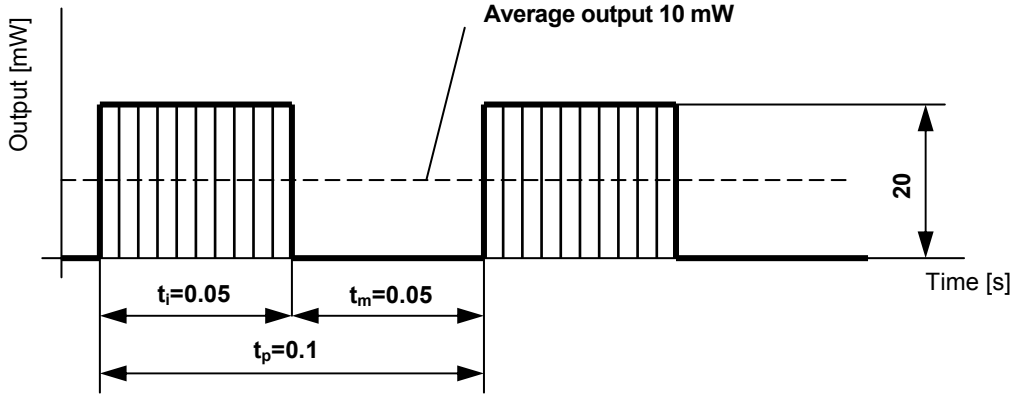
pulse [ms], period [ms] – information about length of the pulse and of the period calculated from the pre-set frequency and duty factor

frequency [Hz] – information about the pre-set frequency

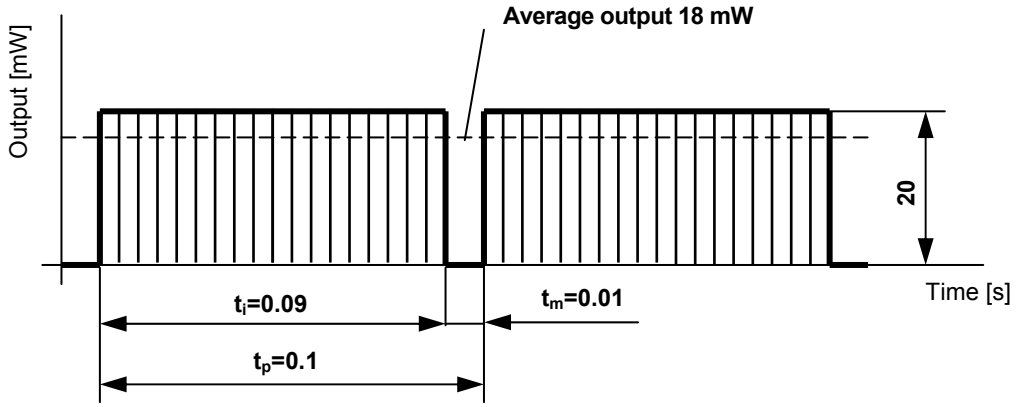
Duty factor (DF) stated in [%] expresses the ratio of the pulse length $\mathbf{t_i}$ to the period $\mathbf{t_p}$ (see picture); it can be set only in the pulse mode.
Change of value of the duty factor considerably influences the value of the average laser output. The following picture shows comparison of two different duty factor settings, all other conditions being equal. From the picture it is apparent that for higher DF the laser emits higher average output which implies shorter time of irradiation.

Comparison of two DF settings

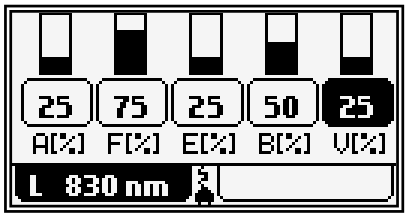
a) f = 10 Hz, P = 20 mW, DF = 50 %



b) f = 10 Hz, P = 20 mW, DF = 90 %



2.2.1.8 Physiological Effects



The symbols of effects used in the device have the following meanings:

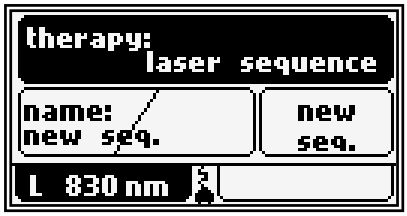
A	analgesic
F	antiphlogistic
E	antiedematous
B	biostimulation
V	vasodilatation

For the factory-preset programs and diagnoses, the effects are filled in. If you are not satisfied with them, you can edit them and save the program as a user one.¨

2.2.2 Laser Sequences

This feature enables to run sequences of therapies selected by name or number of the program. It enables to create new sequences and edit the existing ones.

Since a sequence is a series of individual existing therapies one after another, it is necessary that all programs to be included in the sequence are created before creation of the sequence.
Unlike ultrasound and electro sequences, the laser sequences do not include the time parameter for individual sections. Time for individual sections is displayed only for information and cannot be changed. The reason is that time of individual sections is directly influenced by the dose, which is set in each individual section, and the currently connected probe. Therefore where the probe is replaced, time of individual sections and thus also time of the whole sequence changes. Time changes so that the needed dose is achieved in each section in the sequence. The total time of the sequence is limited to 99:59.
The area is set globally for the whole sequence before the start of therapy.

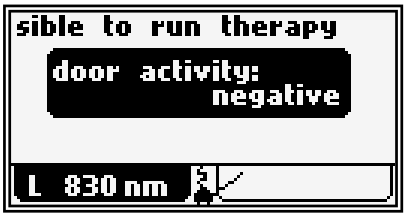


It is possible to set physiological effects in each sequence and to save it among the user programs. For details see Chapter **USER SEQUENCES in the USER'S MANUAL of the BTL-4000 series devices**.

2.3 SPECIFIC SETTINGS

Besides common settings, each generator has some specific setting items. These items are included in the **specific settings** menu item which can differ äccording to which tab (generator) is active. The following part describes specific settings for the laser generator.

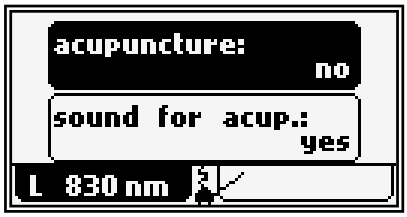
2.3.1 Door Activity



Here it is possible to set when the door is considered open - if it is when voltage is brought or is not brought to the device – see Chapter **2.4 Locking of the Equipment If Door Opens**. The screen displays the door switch setting and its current status; by opening and closing the door you can check if the door status in the device corresponds to the actual status. If not, switch the door activity from positive to negative or vice versa.

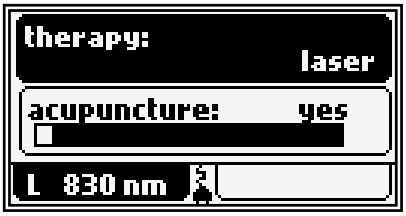
In case of any questions, contact the authorized BTL service department. It is also possible to buy the complete door switch set from the BTL supplier.

2.3.2 Acupuncture



Using a special attachment, the laser generator can measure acupuncture. Since this attachment is not standardly supplied with the device, the acupuncture measuring function is off. This item serves for switching the function on.

When the acupuncture measuring function is on, the acupuncture button appears among therapy parameters in the manual settings screen. After pressing this button you can start measuring of acupuncture. The button displays a horinzontal bargraph the size of which is directly proportional to the skin resistance. The acupuncture point is indicated by a local jump in the skin resistance. During measuring the device generates a sound the pitch of which corresponds to the value on the bargraph. Since basic skin resistance of patients differs, it is possible to change the sensitivity of measuring during the process of acupuncture measuring by the **select** knob.



To find an acupuncture point, slowly sweep the probe with the acupuncture attachment above the place of an expected location of the acupuncture point. After finding the acupuncture point it is possible to start therapy by pressing the button on the probe. During irradiation the device suspends the search mode and returns to it after stopping the therapy or after activating the pause.
Owing to the fact that the acupuncture attachment significantly attenuates the passing laser beam, the equipment corrects the maximum adjustable output when irradiating in the acupuncture mode. If you irradiate using the acupuncture attachment and the acupuncture mode is off, it is necessary to "manually" recalculate the dose or output for the 85% attachment attenuation.

2.3.3 Self-calibration of the Laser Probe

The probes are calibrated by the manufacturer and the user cannot calibrate them. The internal mechanism in the probe automatically checks the reached output during therapy and makes corrections so that the displayed output corresponds to the output generated by the laser probe. If for some reason the probe output does not correspond to pre-set values and it is not possible to correct the error, the probe's internal automatics sets the probe as defective, the probe is locked, and further therapy cannot be performed with it.
Self-calibration is a function which tries to put back into operation the probe which was locked as described above. If self-calibration is run on an unlocked probe, it has no influence on the probe's functioning.

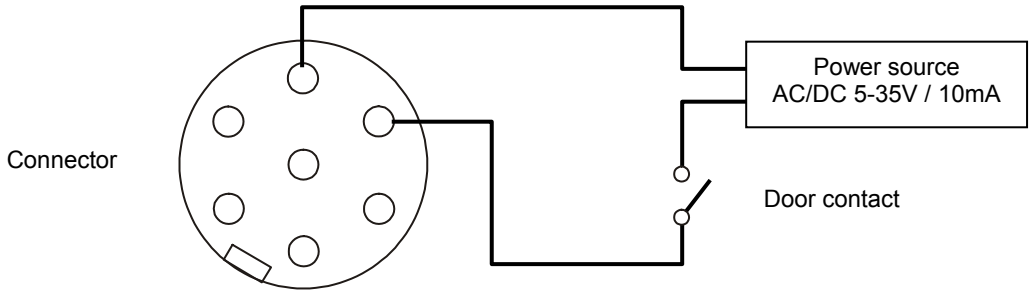
CAUTION
The self-calibration does not in any case replace the required regular calibration and check of the device by the manufacturer or authorized service of BTL-4000 series devices.

2.4 LOCKING OF THE EQUIPMENT IF DOOR OPENS

According to applicable standards, each laser generator must be equipped with the safety door switch which prevents generation of the laser beam if the door is open and there is a real danger of hitting an unprotected person by the laser beam. This door contact is brought to the rear panel of the device. Its position depends on the current configuration of the device – see table **Tab. 2.1 Configuration of output connectors** in the **BTL-4000 Series USER'S MANUAL**.

If the level on the connector's input is active (e.g. in case of open door) the equipment for safety reasons does not allow to run a therapy. If a therapy is already running, it is interrupted (PAUSE status) and the screen displays a warning, optionally together with a sound signal. The therapy can continue only after the signal on the connector's input subsides (i.e. after closing the door), and it can be cancelled by the **esc** button. Any security equipment with voltage output can be connected to this connector. Polarity of voltage does not matter, the equipment detects it and adapts to it. The minimum voltage is 5V, maximum 35V. The current in the connector is max. 10mA. It is possible to pre-set if the switch is considered active in the connected or disconnected status (with or without voltage supply). Defaultly, the switch is set active in the connected status. For details on setting the activity of the door switch see Chapter **2.3.1 Door Activity.** Voltage is brought between the contacts of the connectors 3 and 4.

In case of any questions, contact the authorized BTL service department. It is also possible to buy the complete door switch set from the BTL supplier.

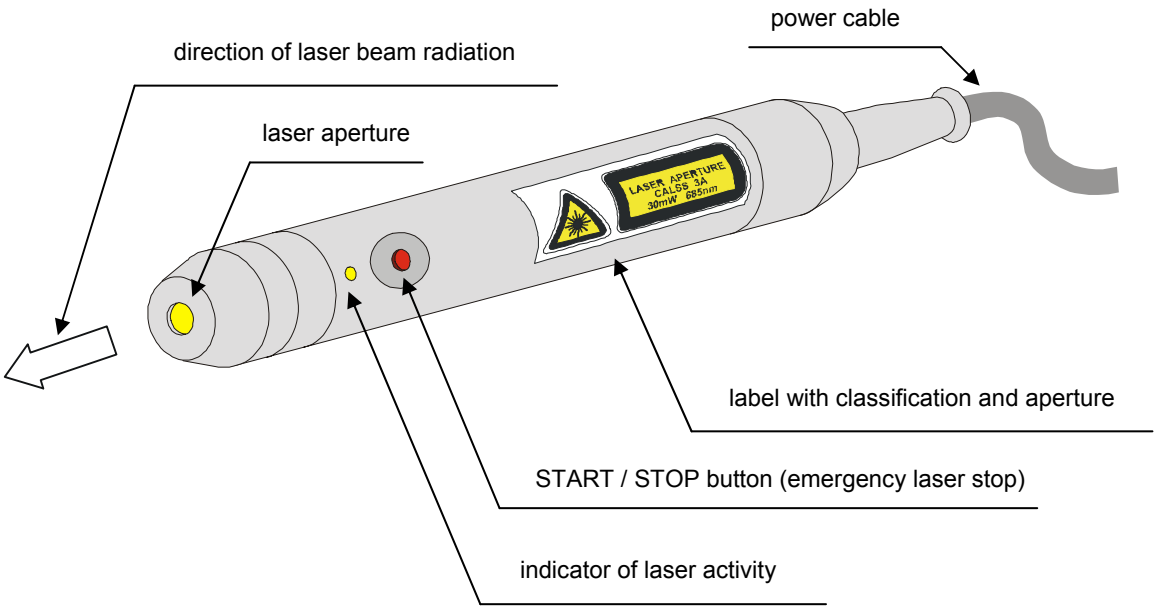


2.5 LASER PROBES

Laser probes are used for laser beam therapy. There are many types manufactured, of various power, and the customers can choose according to their needs.

Division of probes by the wave length:
- Red probes
- Infrared probes

Division of probes by the type of the beam:
- Convergent – point beam (the probes have additional green lighting for better identification of the point of incidence of the beam)
- Divergent beam – enables to irradiate larger area at a time without the need of sweeping over the treated tissue (these probes do not have supplementary lighting).


power cable
direction of laser beam radiation
laser aperture
label with classification and aperture
START / STOP button (emergency laser stop)
indicator of laser activity

Note:
The probes are constructed in the way that the active area of the button does not protrude the outline of the probe. This prevents from accidental pressing e.g. in case of laying the probe on a flat surface (such as a desk, etc.).

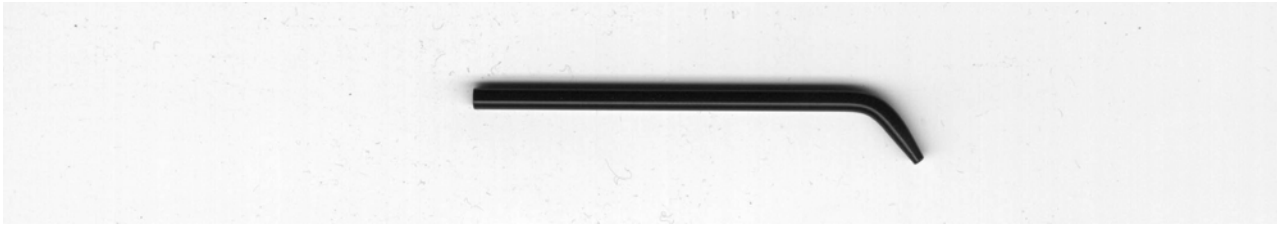
Ageing of the laser probe
The semiconductor laser diodes used in this equipment have a limited lifetime. During this time the diode ages which leads to decrease of its maximum output. Since all laser diodes are calibrated before mounting into the probes, the equipment is able to measure the actual output of the diode and can adjust the maximum output that can be set according to the status of the laser diode. If the output drops under 40 % of the value stated on the probe label (because of a defect or ageing of the diode) we recommend installing a new probe.
According to the value of the probe output just being emitted, the emission of the laser diode is regulated. This ensures that the value on the screen is correct and it is not necessary to use an external measuring device for the probe. Owing to the losses which occur on optical interfaces inside probes, the maximum output that can be pre-set can be lower than the output stated on the probe label.

2.6 OPTICAL ATTACHMENTS

Special lightguide attachments serve for leading the laser beam to hardly accessible places. The range includes attachments for dentistry, gynaecology and otorhinolaryngology (ENT). The lightguide attachments reduce the maximum achievable output of the probe which they are connected to – therefore, when they are used, it is necessary to make adjustment of the dose or output according to the values given below in the parts concerning individual attachments.

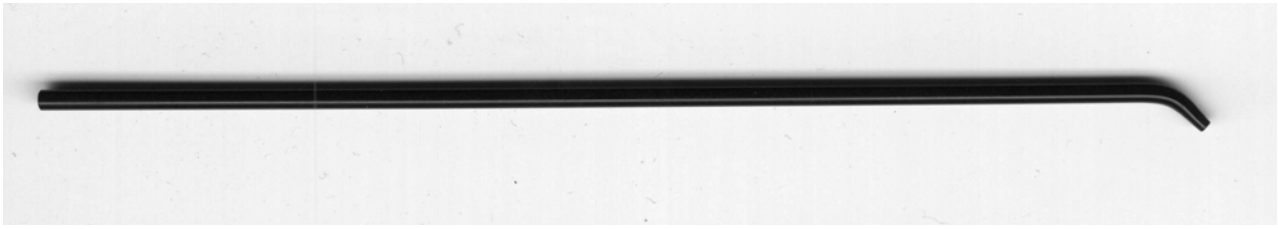
Note: The attachments are not included as standard accessories of the BTL-4000 series devices.

2.6.1 Dental Attachment



When using the dental optical attachment it is necessary to increase the dose by 15 % (when using probes with wavelength of 685 nm or 830 nm).

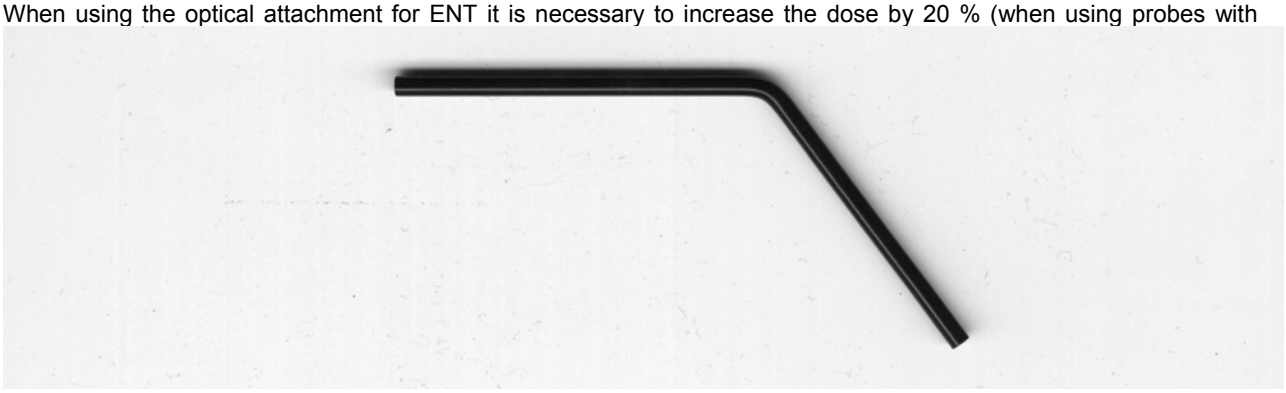
2.6.2 Gynaecological Attachment



When using the gynaecological optical attachment it is necessary to increase the dose by 25 % (when using probes with wavelength of 685 nm or 830 nm).

2.6.3 ENT Attachment

When using the optical attachment for ENT it is necessary to increase the dose by 20 % (when using probes with



2.6.4 How to Connect the Attachment

Unscrew the brass cover of the probe's head. In its place screw the plastic attachment with the light waveguide plugged in. Make sure that the plastic attachment is fixed fast and the light waveguide is immovable. If you want to replace the attachment by another one, simply loosen the head by approximately one thread, take out the previous attachment, put in the new one and tighten the head.

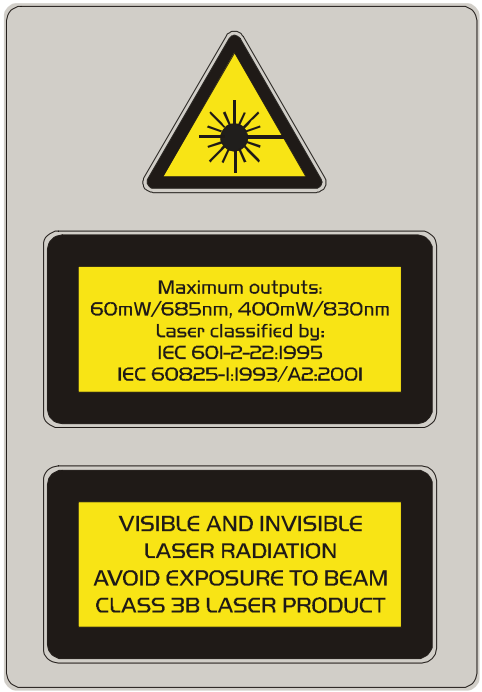
2.7 USE OF SAFETY EYEWEAR

According to applicable standards, both the therapist and patient must use safety eyewear which prevents from damage to eyes in case of undesirable hitting by the laser beam. The protective eyewear supplied by BTL was approved by the Czech Occupational Safety Research Institute and certified under the number 235/T-010/1999.

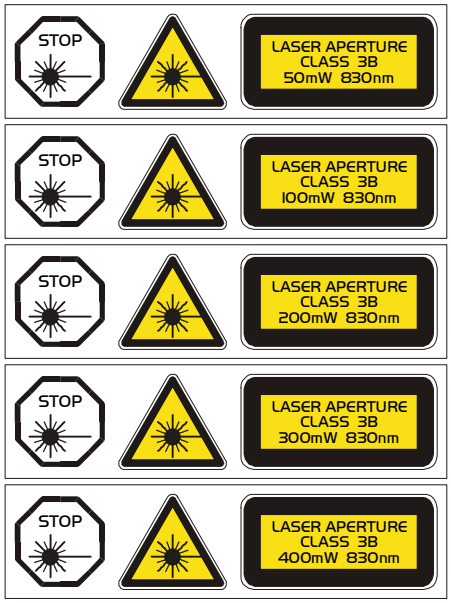
3 APPENDIX

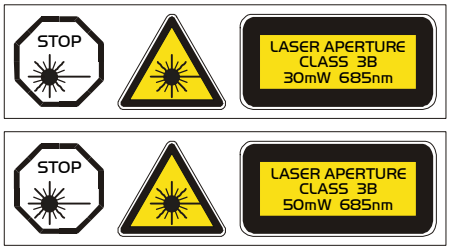
3.1 WARNING LABELS PLACED ON THE CASE OF THE DEVICE AND ON THE LASER PROBE

3.1.1 Label placed on the case of the device, warning about occurrence of visible and invisible radiation of class 3B



3.1.2 Label placed on the probe, warning about proximity of aperture of laser of the stated wavelength, power and laser class





3.1.3 Label for marking of the laser workplace, warning about proximity of 3B-class laser